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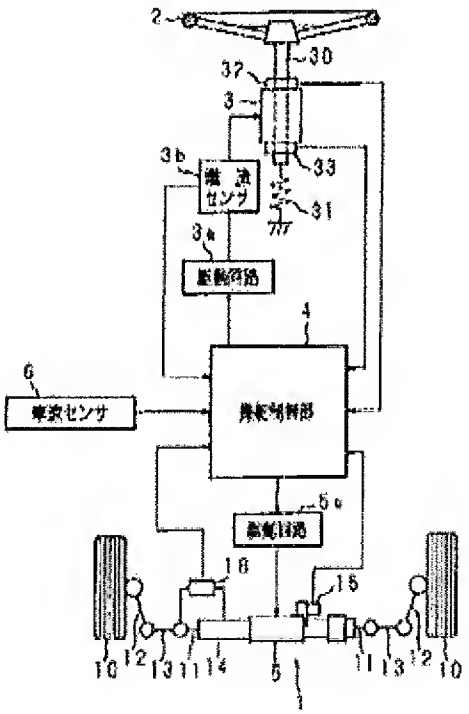
(54) VEHICULAR STEERING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a vehicular steering device in which natural returning of a steering wheel, following returning of wheels to the neutral position by self-aligning torque is realized.

SOLUTION: A vehicular steering device is provided with a steering mechanism 1 for steering wheels 10 by the control amount from a steering means 2, drives a reaction motor 3 according to the steering control amount of the wheels 10, and controls reaction of the steering means 2. Moreover, it is provided with a steering angle detecting means 16 for detecting the steerage angle of the steering mechanism 1, a hand releasing state detecting means 4 for detecting the hand releasing state in returning of the steering means 2 to the neutral position, a reaction stopping means 4 for stopping reaction control of the steering means 2 on the basis of the detected signal of the hand releasing state detecting means 4, and a steering angle control means 4 for controlling the steering angle of the steering means 2 on the basis of the steering angle signal of the steering angle detecting means 16 in stopping of reaction control of the steering means 2.



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CLAIMS

[Claim(s)]
[Claim 1]In steering gear for vehicles which is provided with a steering ****** mechanism for a wheel with a controlled variable from a steersman stage, drives a reaction force motor according to a guide controlled variable of said wheel, and controls reaction force of said steersman stage, A rudder angle detection means to detect a rudder angle of said steering engine style, and a state detecting means without holding which detects a state without holding when returning to a center valve position of said steersman stage, Steering gear for vehicles having a reaction force means for stopping which stops reaction force control of said steersman stage, and a steering angle control means which controls a steering angle of said steersman stage based on a rudder angle signal of said rudder angle detection means at the time of a reaction-force-control stop of said steersman stage based on a detecting signal of this state detecting means without holding.
[Claim 2]In steering gear for vehicles which is provided with a steering ****** mechanism for a wheel with a controlled variable from a steersman stage, drives a reaction force motor according to a guide controlled variable of this wheel, and controls reaction force of said steersman stage, A rudder angle detection means to detect a rudder angle of said steering engine style, and a speed detecting means which detects a travel speed of vehicles, A state detecting means without holding which detects a state without holding when returning to a center valve position of said steersman stage, A reaction force means for stopping which stops reaction force control of said steersman stage based on a detecting signal of this state detecting means without holding, Steering gear for vehicles having a steering angle speed control means which controls steering angle return angular velocity of said steersman stage based on a vehicle speed signal of said speed detecting means, and a rudder angle signal of said rudder angle detection means at the time of a reaction-force-control stop of said steersman stage.
[Claim 3]The steering gear for vehicles according to claim 2 characterized by comprising the following.
A steering angle detection means to detect a steering angle of said steersman stage.
A rudder angle control means which performs control which reduces a rudder angle of said steering engine style based on a steering angle which said steering angle detection means

detected when said state detecting means without holding detects said state without holding.

[Claim 4]Steering gear for vehicles characterized by comprising the following which is provided with a steering ****** mechanism for a wheel with a controlled variable from a steersman stage, drives a reaction force motor according to a guide controlled variable of said wheel, and controls reaction force of said steersman stage.
A rudder angle detection means to detect a rudder angle of said steering engine style.
A state detecting means without holding which detects a state without holding when returning to a center valve position of said steersman stage.
A compensation means which carries out reduction amendment of the reaction force of said steersman stage according to a rudder angle signal of said rudder angle detection means based on a detecting signal of this state detecting means without holding.

[Claim 5]Have a steering torque detecting means which detects steering torque added to said steersman stage, and said state detecting means without holding, A speed comparison means to measure a speed detecting means which detects a travel speed of vehicles, a travel speed which this speed detecting means detected, and a prescribed speed, The steering gear for vehicles according to any one of claims 1 to 4 which it has a torque comparison means to compare with a predetermined value steering torque which said steering torque detecting means detected, and said travel speed is a high speed from a prescribed speed, and detects said state without holding when said steering torque is smaller than a predetermined value.
[Claim 6]Have a steering torque detecting means which detects steering torque added to said steersman stage, and said state detecting means without holding, A speed comparison means to measure a speed detecting means which detects a travel speed of vehicles, a travel speed which this speed detecting means detected, and a prescribed speed, It has a reaction force comparison means to compare a torque comparison means to compare with a predetermined value steering torque which said steering torque detecting means detected with reaction force which should be given to said steersman stage and a predetermined value, and said travel speed is a high speed from a prescribed speed.
The steering gear for vehicles according to any one of claims 1 to 4 which detects said state without holding when said steering torque is smaller than a predetermined value and reaction force which should be given to said steersman stage is larger than a predetermined value.

[Claim 7]Have a steering torque detecting means which detects steering torque added to said steersman stage, and said state detecting means without holding, A speed comparison means to measure a speed detecting means which detects a travel speed of vehicles, a travel speed which this speed detecting means detected, and a prescribed speed, A torque comparison means to compare with a predetermined value steering torque which said steering torque detecting means detected, A differential means which differentiates steering torque which said steering torque detecting means detected, and this differential means are provided with a differential value

comparison means to compare with a predetermined value a value which differentiated said steering torque, and said travel speed is a high speed from a prescribed speed.

The steering gear for vehicles according to any one of claims 1 to 4 which detects said state without holding when said steering torque is smaller than a predetermined value and a value which differentiated said steering torque is larger than a predetermined value.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the steering gear for vehicles for making it steer vehicles according to a driver's operation.
[0002]
[Description of the Prior Art]Steering of vehicles is performed by telling operation of the steersman stage allotted to the inside of a vehicle room, for example, rotation of a steering wheel, to the steering engine style allotted to the exterior of the vehicle room for steering of the wheel for steering (generally front wheel). In recent years, arrange the actuator for steering assistance, such as an oil hydraulic cylinder and an electric motor, on the halfway of a steering engine style, and this actuator is driven based on the detection result of the operating physical force to which it is added by the steering wheel for steering, Operation of the steering engine style according to rotation of a steering wheel is assisted according to the generative force of an actuator, and the power steering gear (power steering device) considered as the composition which eases the labor burden of the driver for steering has spread widely.
[0003]However, in such conventional steering gear for vehicles, The mechanical connection to the steering wheel and steering engine style which are steersman stages is required, Even if it is a case where there is a problem that it is limited to the position in which connection to a steering engine style car outdoor in the arranging position of the steering wheel in the inside of a vehicle room is possible, and a steering wheel is allocated so that connection is possible, Joining structure complicated for realization of connection is required, and it has become a factor which checks the weight saving of vehicles, and the simplification of a fabrication process.
[0004]The steering gear for vehicles which is a linkless power steering device aiming at dissolution of such a problem is indicated by JP,H2-29017,Y. The steering gear for these vehicles separates a steering wheel from a steering engine style, and arranges it, Like the actuator for steering assistance in power steering gear, It has the composition of making steering according to operation of a steering wheel performing, by arranging the electric motor as an actuator for

steering on the halfway of a steering engine style, and driving this electric motor based on the manipulating direction of a steering wheel, and the detection result of a control input.

[0005]The reaction force actuator provided with the motor is attached to the steering wheel which is not mechanically connected with a steering engine style. By driving said motor based on the vehicle speed and the detection result of the steering angle of a steering wheel, a reaction force actuator serves as size according to the height of the vehicle speed, and the size of a steering angle, and applies to a steering wheel the reaction force which goes to a center valve position. Detect the torque which resists this reaction force and is added to a steering wheel, the motor current of the electric motor for steering is made to fluctuate according to this detection result, and the control force which this electric motor generates is made to fluctuate in such steering gear for vehicles. A steering wheel and a steering engine style enable it to have performed steering with the same feeling as the common steering gear for vehicles (connected type steering gear) connected mechanically thereby.

[0006]The steering gear for vehicles of the discrete type constituted as mentioned above, It adds to the purpose which the increase in the allocation flexibility of a steering wheel, the weight saving of vehicles, etc. mentioned above, Realization etc. of the automatic operation system according to running information, such as realization of the new steersman stage replaced with steering wheels, such as a lever and a pedal, and detection of the leading sign on a road surface, and reception of satellite information, are useful because of development of the vehicle technology in the future.

[0007]

[Problem(s) to be Solved by the Invention]However, when a wheel returns to a center valve position (rectilinear-propagation traveling position) by a self-aligning torque at the time of a run, Since only the reaction force which the torque which resists the reaction force mentioned above and is added to a steering wheel is lost, and goes to a center valve position will be applied to a steering wheel when a driver releases his hold of a steering wheel, A steering wheel returns quickly and the steering feeling which a driver receives differs from the steering feeling received from the conventional steering gear.

[0008]When a driver releases his hold of a steering wheel, as what carries out the roll control of the steering wheel, Although a steering wheel has steering gear for vehicles (JP,H4-176781,A) which gives the damping torque for controlling vibration resulting from a road surface condition and a control system at the time of without holding, this is for inhibiting the influence from the road surface condition and control system at the time of without holding. This invention is made in view of a situation which was mentioned above, and is a thing.

The purpose is to provide the steering gear for vehicles which followed the return in the center valve position of the wheel by a self-aligning torque and which realized the return in the center valve position of a natural steering wheel then.

It aims at providing the steering gear for vehicles which can detect a state without holding in the 5-7th inventions.

[0009]

[Means for Solving the Problem]Steering gear for vehicles which this invention requires for the 1st

invention is provided with a steering ****** mechanism for a wheel with a controlled variable from a steersman stage, and is characterized by that steering gear for vehicles which drives a reaction force motor according to a guide controlled variable of said wheel, and controls reaction force of said steersman stage comprises the following.
A rudder angle detection means to detect a rudder angle of said steering engine style.
A state detecting means without holding which detects a state without holding when returning to a center valve position of said steersman stage.
A reaction force means for stopping which stops reaction force control of said steersman stage based on a detecting signal of this state detecting means without holding.
A steering angle control means which controls a steering angle of said steersman stage based on a rudder angle signal of said rudder angle detection means at the time of a reaction-force-control stop of said steersman stage.

[0010]In this steering gear for vehicles, if a driver releases his hold of a steersman stage when a wheel tends to return to a center valve position (rectilinear-propagation traveling position) by a self-aligning torque at the time of a run and a steersman stage returns to the rudder angle middle point (center valve position) in connection with it, a state detecting means without holding will detect that state without holding. A reaction force means for stopping stops reaction force control of a steersman stage based on a detecting signal of a state detecting means without holding, and a steering angle control means controls a steering angle of a steersman stage based on a rudder angle signal of a rudder angle detection means. Thereby, a return in a center valve position of a natural steering wheel which followed a return in a center valve position of a wheel by a self-aligning torque is realizable.
[0011]Steering gear for vehicles which this invention requires for the 2nd invention is provided with a steering ****** mechanism for a wheel with a controlled variable from a steersman stage, and is characterized by that steering gear for vehicles which drives a reaction force motor according to a guide controlled variable of this wheel, and controls reaction force of said steersman stage comprises the following.
A rudder angle detection means to detect a rudder angle of said steering engine style.
A speed detecting means which detects a travel speed of vehicles.
A state detecting means without holding which detects a state without holding when returning to a center valve position of said steersman stage.
A reaction force means for stopping which stops reaction force control of said steersman stage based on a detecting signal of this state detecting means without holding, A steering angle speed control means which controls steering angle return angular velocity of said steersman stage based on a vehicle speed signal of said speed detecting means, and a rudder angle signal of said rudder angle detection means at the time of a reaction-force-control stop of said steersman stage.

[0012]In this steering gear for vehicles, if a driver releases his hold of a steersman stage when a wheel tends to return to a center valve position (rectilinear-propagation traveling position) by a self-

aligning torque at the time of a run and a steersman stage returns to the rudder angle middle point (center valve position) in connection with it, a state detecting means without holding will detect that state without holding. A reaction force means for stopping stops reaction force control of a steersman stage based on a detecting signal of a state detecting means without holding, and a steering angle speed control means controls steering angle return angular velocity of a steersman stage based on a vehicle speed signal and a rudder angle signal at the time of a reaction-force-control stop of a steersman stage. Thereby, a return in a center valve position of a natural steering wheel which followed a return in a center valve position of a wheel by a self-aligning torque is realizable.

[0013]When a steering angle detection means to detect a steering angle of said steersman stage, and said state detecting means without holding detect said state without holding, steering gear for vehicles concerning the 3rd invention, Based on a steering angle signal of said steering angle detection means, it has a rudder angle control means which performs control which reduces a rudder angle of said steering engine style.

[0014]In this steering gear for vehicles, if a driver releases his hold of a steersman stage when a wheel tends to return to a center valve position (rectilinear-propagation traveling position) by a self-aligning torque at the time of a run and a steersman stage returns to the rudder angle middle point (center valve position) in connection with it, a state detecting means without holding will detect that state without holding. A reaction force means for stopping stops reaction force control of a steersman stage based on a detecting signal of a state detecting means without holding, and a steering angle speed control means controls steering angle return angular velocity of a steersman stage based on a vehicle speed signal and a rudder angle signal at the time of a reaction-force-control stop of a steersman stage. A rudder angle control means performs control which reduces a rudder angle of a steering engine style based on a steering angle signal. Thereby, a return in a center valve position of a natural steering wheel which followed a return in a center valve position of a wheel by a self-aligning torque is realizable.

[0015]Steering gear for vehicles which this invention requires for the 4th invention is provided with a steering ****** mechanism for a wheel with a controlled variable from a steersman stage, and is characterized by that steering gear for vehicles which drives a reaction force motor according to a guide controlled variable of said wheel, and controls reaction force of said steersman stage comprises the following.

A rudder angle detection means to detect a rudder angle of said steering engine style.

A state detecting means without holding which detects a state without holding when returning to a center valve position of said steersman stage.

A compensation means which carries out reduction amendment of the reaction force of said steersman stage according to a rudder angle signal of said rudder angle detection means based on a detecting signal of this state detecting means without holding.

[0016]In this steering gear for vehicles, if a driver releases his hold of a steersman stage when a wheel tends to return to a center valve position (rectilinear-propagation traveling position) by a self-

aligning torque at the time of a run and a steersman stage returns to the rudder angle middle point (center valve position) in connection with it, a state detecting means without holding will detect that state without holding. A compensation means carries out reduction amendment of the reaction force of a steersman stage according to a rudder angle signal based on a detecting signal of a state detecting means without holding. Thereby, a return in a center valve position of a natural steering wheel which followed a return in a center valve position of a wheel by a self-aligning torque is realizable.

[0017]Steering gear for vehicles concerning the 5th invention is provided with a steering torque detecting means which detects steering torque added to said steersman stage, and said state detecting means without holding, A speed comparison means to measure a speed detecting means which detects a travel speed of vehicles, a travel speed which this speed detecting means detected, and a prescribed speed, When it has a torque comparison means to compare with a predetermined value steering torque which said steering torque detecting means detected, said travel speed is a high speed from a prescribed speed and said steering torque is smaller than a predetermined value, said state without holding is detected.

[0018]In this steering gear for vehicles, a steering torque detecting means detects steering torque added to a steersman stage. And a speed comparison means measures a travel speed and a prescribed speed, a torque comparison means compares steering torque with a predetermined value, a travel speed is a high speed from a prescribed speed, and a state detecting means without holding detects a state without holding, when steering torque is smaller than a predetermined value. Thereby, a state without holding can be detected and a return in a center valve position of a natural steering wheel which followed a return in a center valve position of a wheel by a self-aligning torque can be realized in a state without holding.

[0019]Steering gear for vehicles concerning the 6th invention is provided with a steering torque detecting means which detects steering torque added to said steersman stage, and said state detecting means without holding, A speed comparison means to measure a speed detecting means which detects a travel speed of vehicles, a travel speed which this speed detecting means detected, and a prescribed speed, A torque comparison means to compare with a predetermined value steering torque which said steering torque detecting means detected, When have a reaction force comparison means to compare with a predetermined value reaction force which should be given to said steersman stage, said travel speed is a high speed from a prescribed speed, said steering torque is smaller than a predetermined value and reaction force which should be given to said steersman stage is larger than a predetermined value, said state without holding is detected.

[0020]In this steering gear for vehicles, a steering torque detecting means detects steering torque added to a steersman stage. And a speed comparison means measures a travel speed and a prescribed speed, a torque comparison means compares steering torque with a predetermined value, and a state detecting means without holding compares reaction force and a predetermined value which a reaction force comparison means should give to a steersman stage, A travel speed is a high speed from a prescribed speed, steering torque is smaller than a predetermined value, and when reaction force which should be given to a steersman stage is larger than a

predetermined value, a state without holding is detected. Thereby, a state without holding can be detected and a return in a center valve position of a natural steering wheel which followed a return in a center valve position of a wheel by a self-aligning torque can be realized in a state without holding.

[0021]Steering gear for vehicles concerning the 7th invention is provided with a steering torque detecting means which detects steering torque added to said steersman stage, and said state detecting means without holding, A speed comparison means to measure a speed detecting means which detects a travel speed of vehicles, a travel speed which this speed detecting means detected, and a prescribed speed, A torque comparison means to compare with a predetermined value steering torque which said steering torque detecting means detected, A differential means which differentiates steering torque which said steering torque detecting means detected, When have a differential value comparison means by which this differential means compares with a predetermined value a value which differentiated said steering torque, said travel speed is a high speed from a prescribed speed, said steering torque is smaller than a predetermined value and a value which differentiated said steering torque is larger than a predetermined value, said state without holding is detected.

[0022]In this steering gear for vehicles, a steering torque detecting means detects steering torque added to a steersman stage. And as for a state detecting means without holding, a speed comparison means measures a travel speed and a prescribed speed, a torque comparison means compares steering torque with a predetermined value, a differential means differentiates steering torque and a differential value comparison means compares the value and predetermined value which were differentiated, A travel speed is a high speed from a prescribed speed, steering torque is smaller than a predetermined value, and when a value which differentiated steering torque is larger than a predetermined value, a state without holding is detected. Thereby, a state without holding can be detected and a return in a center valve position of a natural steering wheel which followed a return in a center valve position of a wheel by a self-aligning torque can be realized in a state without holding.

[0023]

[Embodiment of the Invention]Below, this invention is explained based on the Drawings in which the embodiment is shown. Drawing 1 is a block diagram showing the entire configuration of the steering gear for vehicles concerning the 1st and 5 invention. The steering engine style 1 for this steering gear for vehicles to make steering operation perform for the wheels 10 and 10 for steering of the couple allotted to the right and left of the body which is not illustrated, The steering wheel 2 which is the steersman stage which separated from the steering engine style 1 and was allotted, Have the reaction force actuator 3 which gives reaction force to the steering wheel 2, and the steering control unit 4 which uses a microprocessor, and by operation of the steering control unit 4 according to operation of the steering wheel 2. The steering motor 5 arranged on the halfway of the steering engine style 1 is driven, and it has the composition of operating the steering engine style 1.

[0024]The both ends of the steering shaft 11 which is installed in the longitudinal direction of the

body and slides on an axial length direction so that the steering engine style 1 may be publicly known, the steering knuckle arms 12 and 12 which support the wheels 10 and 10 -- each -- it connecting with another tie rods 13 and 13, and, Push the steering knuckle arms 12 and 12 via the tie rods 13 and 13 by sliding to the both directions of the steering shaft 11, lengthen, carry out, steer right and left the wheels 10 and 10, and this steering, It is carried out to the halfway part of the steering shaft 11 by changing into sliding of the steering shaft 11 rotation of the steering motor 5 constituted in same axle according to a proper motion conversion mechanism.

[0025]The steering shaft 11 is having rotation of the circumference of an axis restrained by the rotating constraint means which was infixed between the steering shaft housing 14 and which is not illustrated, rotation of the steering motor 5 is changed into sliding of the axial length direction of the steering shaft 11, and steering (steering of the wheels 10 and 10 for steering) according to rotation of the steering motor 5 is performed.The rudder angle of the wheels 10 and 10 steered in this way, It carries out through the relative sliding position of the steering shaft housing 14 by the side of one of the steering motor 5, and the steering shaft 11, It has made as [detect / by the rudder sensor 16 which is a rudder angle detection means], and the output of the rudder sensor 16 is given to the steering control unit 4 with the output of the rotary encoder 15 which detects the rotary place of the steering motor 5.

[0026]The reaction force actuator 3 which gives reaction force to the steering wheel 2 is an electric motor (for example, three-phase-circuit brushless motor), and is fixed and attached to the proper part of the body which does not illustrate the casing in relation to the axis of rotation 30. The steering wheel 2 is being fixed to the projecting end by the side of one of the axis of rotation 30 in same axle, and the projecting end by the side of other is connected with the proper part of the body which is not illustrated with the twist spring 31 which has predetermined elasticity.

[0027]The reaction force actuator 3 is driven in right reverse both directions by energization from the drive circuit 3a according to the reaction force indicated torque signal given from the steering control unit 4, and makes the operation which gives the power (reaction force) of the manipulating direction and opposite direction to the steering wheel 2 attached to the end of the axis of rotation 30. Therefore, for the rotatably operating of the steering wheel 2. The steering torque which needs to add the steering torque which resists the reaction force which the reaction force actuator 3 generates, does in this way, and is added to the steering wheel 2, It is detected by the torque sensor 32 attached to the reaction force actuator 3, and the control input (steering angle) of the steering wheel 2, It is detected by the rotary encoder 33 attached to the reaction force actuator 3 including the manipulating direction, and these detection results are given to the steering control unit 4. The current energized from the drive circuit 3a to the reaction force actuator 3 is detected by the current sensor 3b, and is given to the steering control unit 4.

[0028]At the time of the stop of the rotatably operating performed as mentioned above, the twist spring 31 infixed between [some] the other end of the axis of rotation 30 and the body rotates the axis of rotation 30 with the elasticity, and carries out the operation which makes the steering wheel 2 return to a predetermined center valve position. This return is required in order to return the steering wheel 2 in connection with the return operation to the advance direction of the wheels 10

and 10 produced in the steering engine style 1 side separated mechanically.

[0029]To the steering control unit 4, the state of steering actually produced in the steering engine style 1 side as mentioned above, It is given as an input from the rotary encoder 15 and the rudder sensor 16, The state of operation of the steering wheel 2 as a steersman stage is given as an input from the torque sensor 32 and the rotary encoder 33, respectively, and, in addition to these, the output of the speed sensor 6 which detects the travel speed of vehicles is given to the input side of the steering control unit 4.

[0030]The reaction force actuator 3 which gives reaction force to the steering wheel 2 on the other hand as the output of the steering control unit 4 was mentioned above, the steering motor 5 for making steering operation perform to the steering engine style 1 -- each -- it is given via another drive circuits 3a and 5a, and the reaction force actuator 3 and the steering motor 5 embrace the indication signal from the steering control unit 4 -- each -- it has made as [perform / another operation]. The steering control unit 4 determines that the reaction force which should be given to the steering wheel 2 will become size for example, according to the height of the vehicle speed to which it is given as an input from the speed sensor 6, and it performs reaction force control which emits a reaction force indicated torque signal to the reaction force actuator 3 in order to generate reaction force.

[0031]The steering control unit 4 recognizes the operation angle which includes the manipulating direction of the steering wheel 2 by the input from the rotary encoder 33, It asks for a rudder angle deviation with the degree of actual rudder angle recognized by the input of the rudder sensor 16 attached to the steering engine style 1, It amends so that it may become size according to the slowness and fastness of the vehicle speed to which this rudder angle deviation is given as an input from the speed sensor 6, it asks for a target rudder angle, and steering control operation which drives the steering motor 5 is performed until this target rudder angle is obtained. At this time, the input from the rotary encoder 15 is used as a feedback signal for investigating whether the steering motor 5 arrived at the desired rotary place.

[0032]Below, operation of the steering gear for vehicles concerning the 1st and 5 invention of such composition is explained based on the flow chart which shows it. Drawing 2 is a flow chart which shows operation of the steering gear for vehicles concerning the 1st and 5 invention. When a wheel tends to return to a center valve position (rectilinear-propagation traveling position) by a self-aligning torque at the time of vehicle running and the steering wheel 2 returns to a center valve position in connection with it, the steering control unit 4, When the driver is always performing periodically the routine which detects the state of releasing one's hold of the steering wheel 2 (R2) and does not detect the state without holding, the routine of (R4) and the reaction force control mentioned above is performed (R8). When the state without holding is detected, the routine of return control of the steering wheel 2 is performed, without performing (R4) and reaction force control (R6).

[0033]Drawing 3 is a flow chart which shows in detail the routine (R2) which detects the state without holding mentioned above. The steering control unit 4 reads the vehicle speed from the speed sensor 6 (S2), and when this vehicle speed is beyond a predetermined value, it reads the

steering torque of the steering wheel 2 from (S4) and the torque sensor 32 (S6). When this read steering torque (S6) is below a predetermined value, it judges that it is in (S8) and a state without holding, and the return (S10) of it is detected and carried out. When the read vehicle speed (S2) is less than a predetermined value and (S4) or the read steering torque (S6) exceeds a predetermined value, a return is carried out without judging that it is in (S8) and a state without holding.

[0034]Although it has judged that the vehicle speed is beyond a predetermined value, and it is in (S8) and a state without holding when (S4) and steering torque are below a predetermined value in the routine (R2) which detects the state without holding mentioned above, in reaction force indicated torque, the conditions beyond a predetermined value (the deviation of reaction force indicated torque and steering torque -- a large) or the differential value of steering torque other than these two conditions (S4, S8) may add the conditions beyond a predetermined value (steering torque decreases rapidly).

[0035]Drawing 4 is a flow chart which shows in detail the routine (R6) of the return control mentioned above. The steering control unit 4 reads the rudder angle (rack shaft position) of the (drawing 2 R4) rudder sensor 16 empty-vehicle rings 10 and 10, when a state without holding is detected (S12), and it calculates steering wheel target steering angle $theta_M$ according to this rudder angle (S14). Next, the rotary encoder 33 detects steering angle $theta_S$ of the steering wheel 2 (S16), and rudder angle deviation $deltal_n=theta_M-theta_S$ of steering wheel target steering angle $theta_M$ and steering wheel steering angle $theta_S$ is calculated (S18).

[0036]Next, integral-element $I_n=deltal_n x K_I$ (K_I: predetermined constant of integration) of return control is calculated (S20), Proportional element $P_n=(deltal_n-deltal_{n-1}) x K_P$ ($deltal_{n-1}$: the rudder angle deviation of the last cycle, a K_P:predetermined proportionality constant) is calculated (S22). Next, target voltage (reaction force motor target voltage) $V_M=V_0+I_n+P_n$ (V_0: target voltage of the last cycle) of the electric motor of the reaction force actuator 3 is calculated (S24), This target voltage V_M is made to output to the drive circuit 3a, and the electric motor of the reaction force actuator 3 is driven. Next, target voltage V_M is moved to target voltage V_0 of a cycle, rudder angle deviation $deltal_n$ is moved to rudder angle deviation $deltal_{n-1}$ of a cycle last time, respectively (S26), and a return is carried out.

[0037]Drawing 5 is a flow chart which shows in detail the routine (R8) of the reaction force control mentioned above. The steering control unit 4 reaction force indicated torque T_M according to steering angle $theta_S$ of the steering wheel 2 detected by (drawing 2 R4) and the rotary encoder 33 when not detecting a state without holding, It reads from the table of reaction force indicated torque according to a steering angle (S30), and the torque sensor 32 detects steering torque T_S (S32). Next, torque deviation $deltaD_n=T_M-T_S$ of reaction force indicated torque T_M and steering torque T_S

is calculated (S34), and integral-element D_n=deltaD$_n$xK_{I2} (K_{I2}: predetermined constant of integration) of reaction force control is calculated (S36).

[0038]next, proportional element P_n=(deltaD$_n$-deltaD$_{n-1}$) xK_{P2} (deltaD$_{n-1}$: -- the torque deviation of the last cycle.) K_{P2}: Calculate a predetermined proportionality constant (S38) and calculate target current (reaction force motor target current) J_M=J_0+D_n+P_n (J_0: target current of the last cycle) of the electric motor of the reaction force actuator 3 (S40). Next, by the current sensor 3b, current J_S of the electric motor of the reaction force actuator 3 is detected (S42), and current deviation deltaD$_n$'=J_M-J_S of target current J_M of an electric motor and actual current J_S is calculated (S44).

[0039]Next, the steering control unit 4 calculates integral-element D_n'=deltaD$_n$'xK_{I2}' (K_{I2}': predetermined constant of integration) of reaction force control (S46), Proportional element P_n'= (deltaD$_n$'-deltaD$_{n-1}$') xK_{P2}' (deltaD$_{n-1}$': the current deviation of the last cycle, a K_{P2}':predetermined proportionality constant) is calculated (S48). Next, target voltage (reaction force motor target voltage) V_M=V_0+D_n'+P_n' (V_0: target voltage of the last cycle) of the electric motor of the reaction force actuator 3 is calculated (S50), This target voltage V_M is made to output to the drive circuit 3a, and the electric motor of the reaction force actuator 3 is driven. Next, last time target voltage V_M to target current J_0 of a cycle for target current J_M to target voltage V_0 of a cycle. Torque deviation deltaD$_n$ is moved to torque deviation deltaD$_{n-1}$ of a cycle, current deviation deltaD$_n$' is moved to current deviation deltaD$_{n-1}$' of a cycle last time, respectively (S52), and a return is carried out.

[0040]Drawing 6 is a flow chart which shows the routine (drawing 2 R2) of the state detection of the steering gear for vehicles concerning the 2nd, 3, and 6 invention without holding in detail. Since the composition of the steering gear for vehicles concerning the 2nd, 3, and 6 invention and the operation of those other than the routine of state detection without holding and return control are the same as the composition of the steering gear for vehicles and operation concerning the 1st and 5 invention mentioned above, explanation is omitted. The steering control unit 4 reads the vehicle speed from the speed sensor 6 (S80), and when this vehicle speed is beyond a predetermined value, it reads the steering torque of the steering wheel 2 from (S82) and the torque sensor 32 (S84). When this read steering torque is below a predetermined value, (S86) and the reaction force indicated torque according to the steering angle of the steering wheel 2 are read (S88).

[0041]When this read reaction force indicated torque is beyond a predetermined value, the steering control unit 4 judges that it is in (S90) and a state without holding, and detects and carries out the return (S92) of it. When the reaction force indicated torque read when the steering torque (S84) read when the read vehicle speed (S80) was less than a predetermined value (S82) exceeded a predetermined value (S86) is less than a predetermined value (S90), a return is carried out without judging that it is in a state without holding. that is, the vehicle speed is beyond a predetermined value (S82), steering torque is below a predetermined value (S86), and the steering

control unit 4 judges that it is in a state without holding, when reaction force indicated torque is beyond a predetermined value (the deviation of reaction force indicated torque and steering torque -- a large) (S90). The reaction force indicated torque mentioned above may replace with the conditions beyond a predetermined value (S90), and the differential value of steering torque may add the conditions beyond a predetermined value (steering torque decreases rapidly).

[0042]Drawing 7 is a flow chart which shows the routine (drawing 2 R6) of return control of the steering gear for vehicles concerning the 2nd, 3, and 6 invention in detail. The steering control unit 4 reads the rudder angle of the (drawing 2 R4) rudder sensor 16 empty-vehicle rings 10 and 10 (steering engine style), when a state without holding is detected, The travel speed of vehicles is read from the speed sensor 6 (S56), and target steering angle speed $d\theta_M$ of the steering wheel 2 is calculated based on the rudder angle and travel speed which were read (S58).

[0043]Next, the steering control unit 4 from change of steering angle θ_S of the steering wheel 2 detected by the rotary encoder 33. Steering angle speed $d\theta_S$ of the steering wheel 2 is detected (S60), and steering angle velocity-error $\Delta H_n = d\theta_M - d\theta_S$ of target steering angle speed $d\theta_M$ of the steering wheel 2 and actual steering angle speed $d\theta_S$ is calculated (S62). Next, integral-element $H_n = \Delta H_n \times K_{I3}$ (K_{I3}: predetermined constant of integration) of return control is calculated (S64), Proportional element $P_n = (\Delta H_n - \Delta H_{n-1}) \times K_{P3}$ (ΔH_{n-1}: the steering angle velocity error of the last cycle, a K_{P3}:predetermined proportionality constant) is calculated (S66).

[0044]Next, target voltage (reaction force motor target voltage) $V_M = V_0 + H_n + P_n$ (V_0: target voltage of the last cycle) of the electric motor of the reaction force actuator 3 is calculated (S68), This target voltage V_M is made to output to the drive circuit 3a, and the electric motor of the reaction force actuator 3 is driven. Next, target voltage V_M is moved to target voltage V_0 of a cycle, and steering angle velocity-error ΔH_n is moved to steering angle velocity-error ΔH_{n-1} of a cycle last time, respectively (S70). Next, based on steering angle θ_S of the steering wheel (S60) 2 detected by the rotary encoder 33, the steering control unit 4 carries out reduction control of the rudder angle of the wheels 10 and 10 (steering engine style) (S72), and carries out a return.

[0045]Drawing 8 is a flow chart which shows operation of the steering gear for vehicles concerning the 4th and 7 invention. Since the routine of the composition of the steering gear for vehicles and reaction force control concerning the 4th and 7 invention is the same as that of the routine (drawing 2 R8) of the composition of the steering gear for vehicles, and reaction force control concerning the 1st and 5 invention mentioned above, detailed explanation is omitted. When a wheel tends to return to a center valve position (rectilinear-propagation traveling position) by a self-aligning torque at the time of vehicle running and the steering wheel 2 returns to a center valve position in connection with it, the steering gear for vehicles concerning the 4th and 7 invention, When the driver is always performing periodically the routine which detects the state of releasing

one's hold of the steering wheel 2 (R3) and does not detect the state without holding, the routine of (R4) and the reaction force control mentioned above is performed (R8). When the state without holding is detected, after amending the indicated torque of (R4) and reaction force control (R7), reaction force control is performed (R8).

[0046]Drawing 9 is a flow chart which shows the routine (drawing 8 R3) of the state detection of the steering gear for vehicles concerning the 4th and 7 invention without holding in detail. The steering control unit 4 reads the vehicle speed from the speed sensor 6 (S94), and when this vehicle speed is beyond a predetermined value, it reads the steering torque of the steering wheel 2 from (S96) and the torque sensor 32 (S98). When this read steering torque is below a predetermined value, the difference of the steering torque at the time of a sampling cycle and this steering torque is taken and differentiated (S100) and last time (S102).

[0047]When the differential value (absolute value) of this steering torque is beyond a predetermined value, the steering control unit 4 judges that it is in (S104) and a state without holding, and detects and carries out the return (S106) of it. When the steering torque (S98) read when the read vehicle speed (S94) was less than a predetermined value (S96) exceeds a predetermined value (S100), or when the differential value (S102) of steering torque is less than a predetermined value (S104), a return is carried out without judging that it is in a state without holding.

[0048]That is, the vehicle speed is beyond a predetermined value (S96), steering torque is below a predetermined value (S100), and the steering control unit 4 judges that it is in a state without holding, when the differential value of steering torque is beyond a predetermined value (S104) (steering torque decreases rapidly). the differential value of steering torque mentioned above may replace with the conditions beyond a predetermined value (S104), and reaction force indicated torque may add the conditions beyond a predetermined value (the deviation of reaction force indicated torque and steering torque -- a large).

[0049]Drawing 10 is a flow chart which shows in detail the routine (R7) which amends the indicated torque mentioned above. The steering control unit 4 reads the rudder angle of the (drawing 8 R4) rudder sensor 16 empty-vehicle rings 10 and 10 (steering engine style), when a state without holding is detected (S74), according to the read rudder angle, carries out reduction amendment (S76), and carries out the return of the reaction force indicated torque. The steering control unit 4 performs the routine (drawing 5) of reaction force control by the reaction force indicated torque which carried out reduction amendment.

[0050]An above embodiment shows an example of the steering gear for vehicles concerning this invention, and are not the reaction force actuator 3 and a thing which limits the composition of the steering motor 5, It cannot be overemphasized that it can replace with the steering wheel 2 and other control means, such as a lever and a joy stick, can be used as a steersman stage.

[0051]

[Effect of the Invention]According to the steering gear for vehicles concerning the 1-4th inventions of this invention, a return in the center valve position of a natural steering wheel which followed the return in the center valve position of the wheel by a self-aligning torque is realizable.

[0052]According to the steering gear for vehicles concerning the 5-7th inventions, a state without holding can be detected and a return in the center valve position of a natural steering wheel which followed the return in the center valve position of the wheel by a self-aligning torque can be realized in a state without holding.

[Translation done.]